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Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

ENDOGENOUS REPEATED COOPERATION AND SURPLUS DISTRIBUTION - AN EXPERIMENTAL ANALYSIS

Abstract

This paper investigates experimentally how the endogenous group formation combined with the possibility of repeated interaction impacts cooperation levels and surplus distribution. We developed a Surplus Production Distribution Game where the cooperation of four agents is needed to produce a surplus. In case of cooperation, two of the four subjects, the distributors, decided how much of surplus each of them wanted to give to the two other agents, the receivers. This game was played repeatedly with different matching procedures. In the Re-match Treatment (RT) the subjects got randomly re-matched every round, while in the Endogenous-match Treatment (ET) a group was maintained as long as its members cooperated. There was also a Base treatment (BT) where cooperation was exogenously enforced. We found that the distributor's contributions were higher in the ET and the RT than in the BT - unsurprisingly, receivers' possibility to refuse cooperation led to more equal surplus distributions. But contrary to commonly hold beliefs, the possibility of repeated interaction did not lead to higher cooperation levels and more equal allocations of the surplus. Instead, endogenous group formation combined with the possibility of repeated interaction led to self-selection of the subjects in the ET. The endogenous group duration varied drastically between different groups in the ET, with long-lived groups exhibiting contributions and cooperation levels higher than in the RT, while short-lived groups showed contributions and cooperation levels lower than in the RT. Furthermore, for given contribution levels, receivers were more likely to refuse cooperation when their average relationship length was short. This shows that long-lived groups consisted of generous distributors and not so demanding receivers, while ungenerous distributors and demanding receivers formed short-lived groups. Hence, the possibility of repeated interaction does not necessarily increase cooperation and efficiency levels when combined with endogenous group formation. Rather, such a situation might lead to self-selection of agents.

JEL Classification: C92, D03

Keywords: repeated cooperation, surplus distribution, group formation

Georg Kirchsteiger - gkirchst@ulb.ac.be
ECARES, SBSEM, Université libre de Bruxelles and CEPR

Sibilla Di Guida - sidg@sam.sdu.dk
Syddansk Universitet

The Anh Han - T.Han@tees.ac.uk
School of Computing, Teesside University

Tom Lenaerts - tlenaert@ulb.ac.be
MLG, Université libre de Bruxelles and Ai-lab, Vrije Universiteit Brussel

Ioannis Zisis - jzgreek23@gmail.com
MLG, Université libre de Bruxelles

1. Introduction

One defining aspect of human life is cooperation. Cooperation is at the core of the relations between family members and friends. Cooperation between co-workers is crucial for any employment relationship. While cooperation fulfils many needs of human beings, one main reason for the paramount importance of cooperation is the production of surplus. A group cooperating together can achieve more than the sum of what each individual can achieve on his/her own. This holds true for the members of a paleolithic hunter/gatherer group as well as for the founders of a modern startup.

While the ability to produce surplus is one of the main reasons for the importance of cooperation, it also has the potential to lead to efficiency reducing conflicts. It is well known that subjects care about allocative fairness and may even give up own payoff in order to prevent unfair outcomes. (for an overview of the experimental evidence see e.g. Cooper and Kagel 2013). In our context this implies that if the distribution of the surplus is not satisfactory for all cooperating agents, some agents might stop cooperating; and if an unsatisfactory surplus distribution is foreseen, cooperation might be prevented from the very beginning. Hence, successful cooperation requires a split of the surplus that is satisfactory for all agents needed to produce the surplus.

Obviously, if enforceable contracts can be signed a-priori, the problem of a satisfactory surplus distribution can be easily solved. But such contracts are often not feasible, e.g. because it might be impossible to foresee all the contingencies that can occur during the surplus production. Without binding a-priori contracts, the final surplus distribution is determined by the bargaining power the agents have after the surplus is already produced. In case agents have very uneven bargaining power[1], cooperation might be refused a-priori from those agents who expect to have low ex-post bargaining power.

If the interaction is repeated, it seems as if the problem of uneven bargaining power is reduced or even solved, leading to efficient cooperation and satisfactory surplus distribution. The reasoning is simple: The threat of refusing cooperation in the future by the weak ones forces the strong ones to accept a surplus distribution that is satisfactory for all the parts involved. Take for example a group of workers that get a joint bonus if their joint production fulfils some criteria, and assume that one of the co-workers (e.g. the foreman) has a decisive influence on the distribution of the bonus between himself

[1] Bargaining theories have identified some of the several reasons for uneven bargaining power. Within the alternating offer models of bargaining, differences in patience are translated into differences in bargaining power. The outside options are crucial for the Nash Bargaining solution, and these outside options might be very different for different agents. For example, only a subset of the agents might be the legal owners of the surplus for cultural or legal reasons. Or some agents might have (better) weapons, etc.

and the others. If the foreman would ensure himself the lion share of the bonus, his co-workers would refrain from cooperating next time, and this threat forces the foreman to find a fair distribution (whatever might be perceived as fair in the particular context).

The well-known folk theorem (see Fudenberg and Maskin 1986) is often interpreted as showing that repeated interaction leads to an efficient outcome.[2] However, this analysis does not take into account that in many contexts agents might not only refuse to cooperate with given partners, but might also switch partners altogether. Again, take the example of the working group. Unfairly treated workers might decide to quit and look for another job, possibly making it harder for the remaining group members to fulfil the criteria for the bonus.

In this paper we analyze experimentally how the endogenous possibility of repeated cooperation impacts the cooperation level and the surplus distribution. We developed a "surplus production distribution game" where groups consisting of two distributors and two recipients were formed. In each round of the game, group members first had to decide individually whether to cooperate or not. This decision was the same for both types of subjects, and full cooperation was needed for surplus production. Otherwise, if at least one subject refused to cooperate, no surplus was produced and all group members earned nothing this round. If all four members decided to cooperate, the surplus was produced. To model a situation with unequal ex-post bargaining power, each of the distributors received half of the surplus which she[3] could then freely distribute between herself and the recipients, with a fixed minimum contribution. The surplus contributed by both distributors to the receivers was split equally between both receivers[4]. Obviously, in this setting there is little incentive for distributors to refuse cooperation since they have all the ex-post bargaining power, anyhow. But receivers might have an incentive to refuse cooperation if they are afraid that they would be treated unfairly by the distributors. To allow receivers to make informed cooperation decisions, they were informed about the last three contributions made by "their" distributors before the decision about cooperation was taken.

[2] The folk theorem states that in an infinitely repeated game with patient players any surplus distribution is a subgame perfect outcome that gives all agents an average payoff larger than the payoff of an equilibrium of the one-shot game. This result shows that many outcomes can be supported by a subgame perfect equilibrium, and nothing guarantees that all players will cooperate at an efficient level when this is not already the unique equilibrium of the one-shot game. But many applications of repeated games just assume that the actual outcome is efficient, i.e. that repeated interaction leads to efficient cooperation.

[3] We stick to the convention that distributors are female and receivers male.

[4] There were no explicit cooperation costs. But by an appropriate redefinition of the surplus and the contributions we could incorporate cooperation costs as long as they are not sunk when at least one group member does not cooperate.

This game was played repeatedly, with group composition procedures that differed between the treatments. In the Re-match treatment (RT), the same subjects interacted once and got exogenously re-matched after each round. In the Endogenous-match treatment (ET) subjects could maintain the same group composition. A group that cooperated in round t stayed together also in round t+1. If at least one member of the group did not cooperate in round t, no surplus is produced and distributed in round t. Furthermore, these subjects get randomly re-matched with other partners in the next round t+1. We linked the decision to refuse cooperation with the decision to split the group for the following reason: If contrary to the actual design a non-cooperating group had been maintained in the next round t+1, subjects would have found themselves in exactly the same position at the beginning of round t+1 as they had been at the beginning of round t. To avoid this, we imposed that if at least one member of the group did not cooperate in round t, the group got split up and the group members got randomly re-matched with other subjects in round t+1.

In a Baseline-treatment (BT) we enforced cooperation, and subjects got re-matched every round. Hence, BT was equivalent to the dictator game but with two dictators (i.e. distributors) and two receivers forming a match. Comparing BT with the other two treatments allows us to evaluate the impact of the receivers' ability to refuse cooperation on the surplus distribution.

As expected, receivers' cooperation decisions limit the impact of distributors' bargaining power. Distributors' contributions were about two times larger in the RT and the ET than in the BT. As a consequence, distributors' payoffs were highest and receivers' payoffs were lowest in the BT.

On the other hand, the impact of the possible repeated cooperation was surprisingly subtle. Contrary to our expectations, average cooperation levels and average contributions were not significantly higher in the ET than in the RT. Consequently, also the average payoffs of both types of subjects were similar in both treatments. But closer inspection of the data revealed that in the ET the number of periods a group stayed together ("group duration") differed substantially between the groups, and cooperation and contribution levels were closely linked with the group duration. Short-lasting groups showed low levels of cooperation, and to the extent that cooperation happened in these groups at all, the contributions were low. As a consequence, the payoffs of both types of subjects were below the RT level in short-lived ET groups. Furthermore, we found that for the same distributors' prior contributions receivers belonging to short-lasting groups were more likely to refuse cooperation than receivers in long-lasting groups. Hence, short-lasting groups were characterized by "un-generous" distributors and "demanding" receivers. On the other hand, in long-lasting ET groups cooperation levels were high, and distributors' contributions were larger than the average contributions in the RT. And due to the high cooperation

rate, both distributors and receivers belonging to such groups earned more than their counterparts in the RT. Hence, long-lasting groups were composed of generous distributors and not very demanding receivers. This indicates self-selection of the subjects in the ET: Generous distributors and un-demanding receivers formed long-lasting groups, while un-generous distributors and demanding receivers were members of short-lived groups.

In the literature, the theoretical and experimental investigation of cooperation focusses mainly on prisoner's dilemma games, starting with the classical study of Rapoport and Chamah (1965). Like our paper, much of the existing analysis of prisoner's dilemma games has concentrated on the impact of repetition on cooperation (see e.g. Kreps et al. 1982 or Clark and Sefton 2001). But in this literature repeated interaction is exogenously given. The same holds about the surplus distribution in case of cooperation. To our knowledge none of the existing studies on repeated prisoner's dilemma games has investigated how the endogenous possibility of repeated cooperation impacts the cooperation level and the surplus distribution.

Our paper is also linked to the extensive literature on bargaining experiments, in particular ultimatum and dictator game experiments (see e.g. Gueth et al. 1982 and Forsythe et al. 1994; for an overview see of the experimental results of these games see Hoffman et al 2008). The results of the dictator games show that subjects do not use all their bargaining power if this would lead to a very unequal allocation. But in these experiments subjects and in particular receivers cannot decide about cooperation. Rather, the surplus is exogenously given. Furthermore, the matching is exogenous. Hence, dictator game experiments cannot investigate how the endogenous possibility of repeated cooperation impacts cooperation level and the distribution of the surplus.

The ultimatum game is more similar to our surplus production distribution game insofar as in the ultimatum game the subjects with the low bargaining power can refuse to cooperate. The experimental results show that this possibility leads to more equal allocations than in the dictator games. But unlike in our experiment, the cooperation decision of ultimatum games is made by the receivers after they already know what how the surplus is shared in case of cooperation. Hence, the ultimatum game models a situation where binding a-priori contracts are feasible. Furthermore, in most ultimatum game experiments the matching is exogenous and therefore not connected to the cooperation decision. Like dictator games, ultimatum game experiments cannot investigate how the endogenous possibility of repeated cooperation impacts cooperation level and the distribution of the surplus.

Finally, our paper is connected to the experimental work on group formation. Group formation is investigated mainly in the context of public good games. Some papers investigate what happens to voluntary contributions to a public good when groups are formed according to some exogenously given criteria (e.g. Gächter and Thöni 2005 were group members are exogenously matched according their past contributions to the public good). Experiments on endogenous group formation focus on particular aspects of group formation: restricted vs free entry and exit (Ahn et al. 2008), group formed on the basis of stated preferences (Page et al. 2005), the possibility of exclusion (Cinyabuguma et al. 2005 and Riedl and Ule 2002), and mobility between groups (Ehrhart and Keser 1999). In contrast to this literature, our experiment focusses on the links between the possibility to keep the same group, the cooperation levels, and the surplus distribution. To our knowledge, the only other paper connecting partner choice with surplus distribution is Debove et al. 2015. But unlike our paper, they focus on the impact of competition within stable groups characterized by excess supply of either distributors or responders.

The rest of the paper is organized as follows: In the next section we describe the experimental design. Then we specify the hypothesis to be tested. In section 4 we describe the experimental results, and the last section concludes.

2. Experimental design

At the beginning of the session, participants were randomly assigned to the role of distributor and receiver. The role was maintained through the experiment, which lasted for 30 rounds. As already explained, there were three treatments: A Re-match Treatment (RT) where subjects got re-matched every round so that they could cooperate with the same partners at most once; an Endogenous-match Treatment (ET) where the same subjects could cooperate as long as they wanted (within the limits of the duration of the session); and a Base treatment (BT) where subjects got re-matched every round and cooperation was exogenously enforced.

In each round of the BT all participants were randomly grouped in groups of four subjects each, composed by two distributors and two receivers. In each round, a surplus of 20 ECUs ("Experimental Currency Unit") was exogenously given. This surplus was equally split between the distributors. Then each distributor decided individually how much of her 10 ECUs keep for herself, and how much give to the matched receivers. The minimum contribution was 1 (to avoid multiple equilibria in the game), the maximum 10 ECUs. The contributions of the two distributors were then summed up and divided equally between the two receivers.

The RT consisted of two phases. The first phase lasted three rounds and was identical to the BT - cooperation was exogenously enforced, the surplus was distributed by the distributors, and the subjects got re-matched every round. This phase was necessary to build a history of contributions for the distributors. In the second phase (from round 4 to round 30) groups were also randomly re-matched every round. In reach round after the matching, all subjects were informed about the three previous contributions of the distributors they were matched with[5]. Then each group member (both distributors and receivers) decided whether to cooperate or not. If all members decided to cooperate, the group proceeded as the BT groups. If at least one of the members decided not to cooperate, no surplus was produced and nobody of this group earned anything for that round.

In the ET the members of a group could decide to stay together and cooperate for more than one round. In the first round participants were randomly matched. For the first three rounds, these groups stayed together, cooperation was exogenously enforced, and the distributors made unilateral decisions about their contributions. From round 4 onwards, at the beginning of each round each member decided whether to cooperate or not. If all four members of a group decided to cooperate, the surplus was produced, and the distributors allocated the surplus. If at least one member decided not to cooperate, no surplus was produced, all members of the group earned nothing in this round, and the group was dissolved. At the beginning of the next round, all subjects whose groups were dissolved in the last round were randomly re-matched. The newly matched group members got informed about the last three contributions of their distributors, and they decided about whether to cooperate, etc.

In all three treatments, a distributor's payment was the sum of all the ECUs she had kept for herself in all those rounds where all members of her group cooperated. A receiver earned the sum of the ECUs he had received in those rounds where all members of his group cooperated. ECUs were transformed into Euros with a 10 to 1 exchange rate. 2.5 Euros were added as show-up fee and 2.5 Euros as payment for filling in an optional questionnaire on personal information at the end of the experimental session.

Before the experiment started, participants were randomly allocated to cubicles, instructions were read aloud by a lab assistant, and participants had to answer a control questionnaire to assure that they understood the mechanisms of the experiment. Once everyone answered correctly all the questions (explanations were repeated if necessary), the experiment started. After the experiment was concluded, participants had to fill a brief questionnaire, and then they were paid privately in cash.

[5] Subjects were informed about the distributors' contributions of the last three rounds the distributors were part of a cooperating group. Rounds without surplus were not reported.

3. Hypothesis

Applying backward induction, it is easy to see that when all subjects are purely selfish and fully rational, the distributors would contribute the minimum amount of 1 ECU in every round of every treatment where there is surplus to be distributed. In the RT and the ET, all subjects would cooperate in all rounds. As a consequence, all ET subjects would stay in the same group during all rounds. As already explained, the experimental results of dictator games suggest that distributors would contribute more than the minimum. Furthermore, ultimatum games results suggest that the possibility to refuse cooperation should lead to higher contributions in the RT and the ET than in the BT. Lower contributions in the BT imply higher distributors' earnings in the BT than in the other two treatments. Concerning receivers' earnings, two opposing effects were possible. On the one hand, larger contributions would imply larger receivers' earnings in the RT and the ET than in the BT. On the other hand, the refusal to cooperate could lead to smaller earnings of the receivers in the RT and the ET than in the BT. We expected the first effect to dominate. These considerations led to:

Hypothesis 1:

i) Contributions are smaller in the BT than in the RT and the ET.

ii) Distributors' earnings are higher in the BT than in the RT and the ET.

iii) Receivers' earnings are smaller in the BT than in the RT and the ET.

Next, we turn to the main question of the paper, namely the impact of the possibility of long-term cooperation. We expected that this possibility would lead to more cooperation and larger contributions of the distributors in the ET than in the RT, implying higher earnings for receivers in the ET than in the RT. For the distributors earning, the higher contributions and the larger cooperation rates would have opposing effects, and we expected the effect of the larger cooperation rates to dominate. These considerations led to

Hypothesis 2:

i) Cooperation rates are higher in the ET than in the RT.

ii) Contributions are higher in the ET than in the RT.

iii) Distributors' and receivers' earnings are higher in the ET than in the RT.

Furthermore, we expected that in the ET the endogenous life spans of the groups ("group duration") varied significantly. Since distributors have no reason to refuse cooperation, receivers determine group duration.[6] We expected that receivers' likelihood to cooperate and to maintain the group should depend on two factors. First, receivers' cooperation should be more likely the larger the distributors' past contributions. Hence, the larger the distributors' past contributions, the longer a group should stay together. Second, receivers might differ in how demanding they are. For given past distributors' contributions the likelihood of cooperation is larger for the less demanding receivers. Hence, we expected less demanding receivers belonging to longer-lived groups. Finally, due to the increase in cooperation and contribution levels also the payoffs of both types of subjects should increase in the group duration. These considerations led to:

Hypothesis 3: In the ET the following holds:
i) The longer a group stays together, the higher the distributors' contributions.
ii) The likelihood of cooperation increases in the observed contribution levels of the distributors, and in the average length the receivers stay in the same group.
iii) The longer a group stays together, the higher the earnings of both types of subjects.

Next, we confront these hypotheses with the experimental results.

4. Results

We ran the experiments at the Cologne Laboratory for Economic Research, University of Cologne. The BT sessions lasted less than 40 minutes and the RT and the ET sessions about one hour. The average earning was 20 euro and a minimum earning aligned with the lab policies was guaranteed.
Overall 400 subjects took part in 13 experimental sessions.[7] We have personal data of 356 participants[8]. Of these 356 subjects 157 were male, and the average age was 24.4 years.
Table 1 summarizes the data.

	Subjects	Sessions	Avg. contributions	Avg. Earning Dist.	Avg. Earning Rec.	Avg. Cooperation Rate

[6] In fact we observed hardly any refusal of cooperation by distributors (in the ET, only 2.55% of all refusals to cooperate were done by distributors).
[7] We ran other 2 sessions that had to be discarded due to technical problems.
[8] For legal reasons, the post-experiment questionnaire was optional and some of the participants decided not to fill it.

BT	96	3	2.01	28.97	11.03	/
RT	148	5	3.57	20.00	13.35	0.86
ET	156	5	3.75	19.70	13.72	0.86

Table 1: Summary of the data

The average contribution of 20.1% of the BT is in line with the results of the standard Dictator Game experiments. In the other treatments, the threat of refusing cooperation causes distributors to raise their contributions to a 30%-40% share, similar to what is observed in Ultimatum Games.

We first turn to Hypothesis 1. We perform our first analysis at the session level (using session averages), since each session is an independent observation.

	Difference	lower	upper	Adjusted p-value
Table 2a: Session average contributions				
$F(2,10) = 53.67$, $p < 0.001$, $\eta^2 = 0.91$				
RT – BT	1.560	1.073	2.048	< .001
ET – BT	1.738	1.251	2.225	< . 001
ET - RT	0.177	-0.244	0.599	0.506
Table 2b: Session average distributors´ earnings				
$F(2,10) = 166.2$, $p < 0.001$, $\eta2 = 0.97$				
RT – BT	-8.964	-10.485	-7.442	< .001
ET – BT	-9.268	-10.790	-7.746	< . 001
ET – RT	-0.304	-1.622	1.013	0.805
Table 2c: Session average receivers´ earnings				
$F(2,10) = 9.87$, $p < 0.01$, $\eta2 = 0.66$				
RT – BT	2.318	0.588	4.049	= .01
ET – BT	2.681	0.950	4.411	< . 01
ET - RT	0.363	-1.136	1.861	0.789

Table 2: Values for the 95% family-wise confidence level, Tukey's 'Honest Significant Difference' method.

Average contributions and receivers' earnings are significantly lower in the BT than in the other treatments (see Tables 2a and 2c), while distributors' earnings are significantly larger (see Table 2b).[9]

[9] Since we are comparing more than two groups at a time, it would be incorrect to just compare groups pairwise using a *t*-test because of the well known "problem of multiple testing". The standard solution in these situations is

Figure 1 shows the evolution of the average contributions over time in the three treatments. In all but the last round the contributions were lower in the BT than in the other treatments. To test for time effects, we compared the sessions´ averages of contributions and earnings of rounds 4 to 13 with those of rounds 20 to 29[10] for each treatment. No time effect was observed (Paired t test: BT: $t(2) = 0.64$, $p = 0.59$; RT: $t(4) = 1.80$, $p = 0.15$; ET: $t(4) = 0.40$, $p = 0.71$).

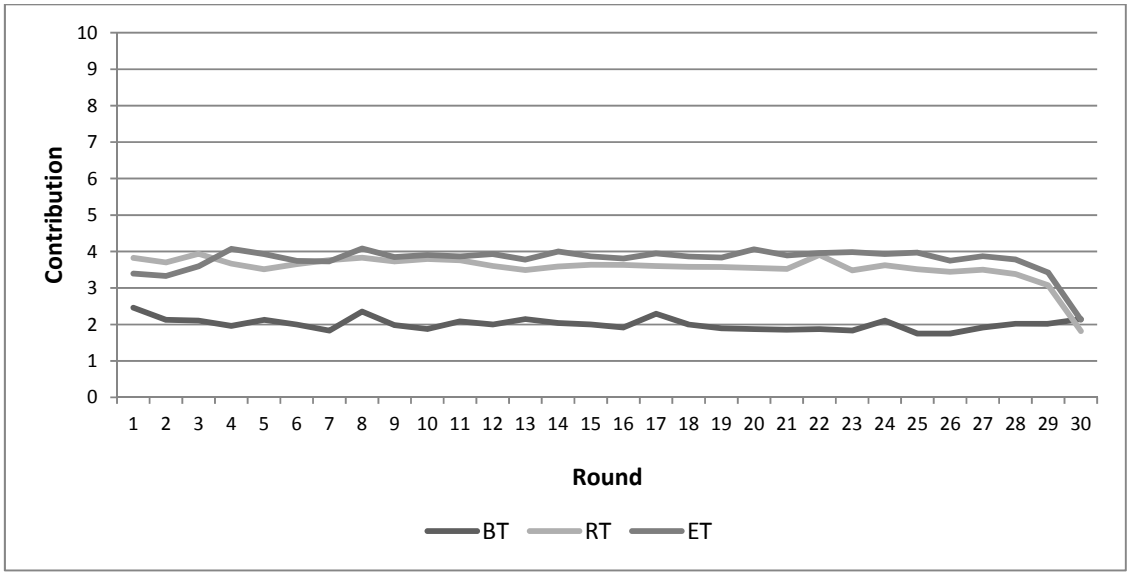

Figure 1: Average contribution by round and treatment

Overall, we can conclude that Hypothesis 1 is supported by the data.

To our surprise, Hypothesis 2 was rejected by the data. Tables 2a-c as well as Figure 1 reveal that there is no significant difference in average contributions and average earnings between the RT and the ET. Furthermore, average cooperation rates (calculated as the number of times a receiver or a distributor has cooperated, averaged by session) in the RT and the ET are undistinguishable (two sample t test: $t(6.04) = 0$, $p = 1$).

For both treatments we investigated how many subjects cooperated a specific number of times (minimum 12, maximum 27). According to a Kolmogorov Smirnov test, the two distributions are not significantly different ($D = 0.13$, $p = .99$). We also calculated the cooperation rates for a given a specific

to first use an F test to evaluate whether there is any evidence that the means of the populations differ; if this is the case, a Tukey multiple comparison test is then used to check for pairwise differences. Tukey´s test is more apt than a *t*-test since it is adjusted for multiple testing.

[10] We excluded the first three rounds, where non-cooperation was not possible, and the last round, where we observed the well-known "end of the experiment effect".

history of contributions. To obtain the cooperation rate given a specific history of contributions, we counted for each session how many times a receiver did not cooperate when "their" distributors average contribution of the last 3 rounds was within one of the following intervals: 0-1.5, 1.6-2.5, 2.6-3.5, 3.6-4.5, 4.6-5.5 (we never observed an average contribution higher than 5.5). We then grouped the sessions of the same treatment together and compared the distributions between treatments. Again, the distributions of the two treatments are undistinguishable (Kolmogorov Smirnov Test: $D = 0.2$, $p = 1$).

Given these results, we have to reject Hypothesis 2. At least on average, RT and ET results cannot be distinguished – the possibility of long-term relationships seems to have no impact on cooperation and the distribution of the surplus. To investigate this issue further, we analyze the impact of the life span of the groups in the ET. Since during the first three rounds groups had to cooperate, we take only rounds 4 to 30 into account. Recall that during these rounds a refusal to cooperate ends the group relationship and the members get randomly re-matched in the next round (unless they were already in the last round). Except for those groups that stayed together the whole experiment, i.e. for all 27 rounds, the life span of a group ("group duration")[11] equals the number of rounds where all group members cooperated plus 1. For example, if a group was matched in round 15, cooperated from round 15 to round 17, and at least one member refused to cooperate in round 18, the group duration is 4 rounds and they cooperated 3 times. In figure 2, we plot the number of groups with their duration, weighted by the duration of the group[12].

[11] The minimum duration is 1, while the maximum is 27, since in the first 3 rounds the groups were forced to cooperate.

[12] Weighting by the duration of the group is necessary to avoid misleading results. To see this, take a hypothetical session with 16 subjects and 27 rounds. In this session, half of the subjects stay always in the same group (i.e. two completely stable groups), while the other groups never cooperate and hence always split after one round. In this case we have 2 groups with a duration of 27 rounds each, and 54 groups with a duration of 1. Taking only the number of groups with the different durations would give the impression as if groups of duration 1 would completely dominate the session, while in fact the actual distribution of subjects into the short and the long term groups is half/half.

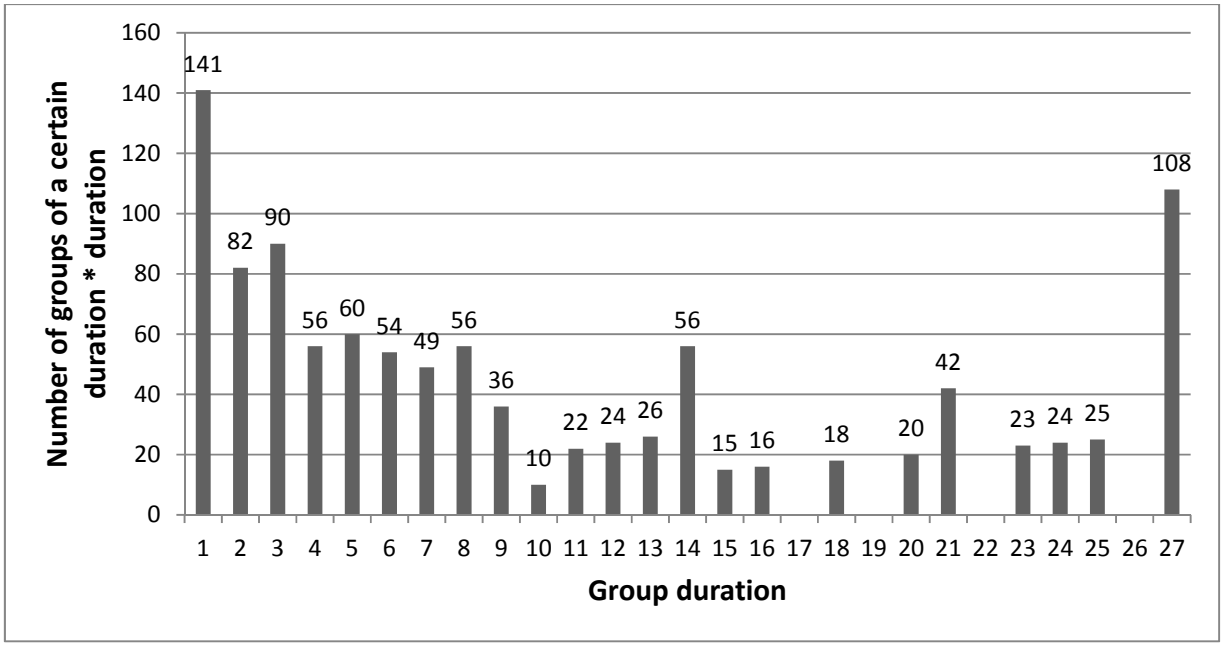

Figure 2: For each possible duration of a match, how many groups stick together for that amount of rounds times the duration of the match

Figure 2 gives us an idea of how long groups were maintained in the ET. For example, 141 groups broke up immediately since in these cases at least one member of the group refused to cooperate already at the first round the group was together (groups of duration 1). 41 groups cooperated once and refused cooperation in the second round of their existence (duration of 2). Overall, Figure 2 reveals a large heterogeneity of group durations, with a lot of short-lived groups, but also quite some long-term relationships.

Does the surplus distribution differ with the groups' life spans? Note that for duration-1-groups we do not observe any surplus distribution, since these groups did not cooperate at all. Hence we restrict the analysis to groups with duration of at least 2. The sample of all those groups was divided into three different categories of (roughly) equal size: Short-lived groups with a length of less than 6 rounds. This category includes 288 duration-weighted groups. Medium stable groups that cooperated between 6 and 13 rounds (277 duration weighted groups), and long-lived groups that cooperated for more than 13 rounds (347 duration weighted groups). Contributions of distributors in long-lived groups are significantly higher than those of distributors of short-lived groups (two sample t test, short-lived groups – long-lived groups, $t(900.75) = -25.31$, $p = < .001$)).

Furthermore, Figure 3 suggests a positive correlation between a distributor´s average relationship-length and her contributions.

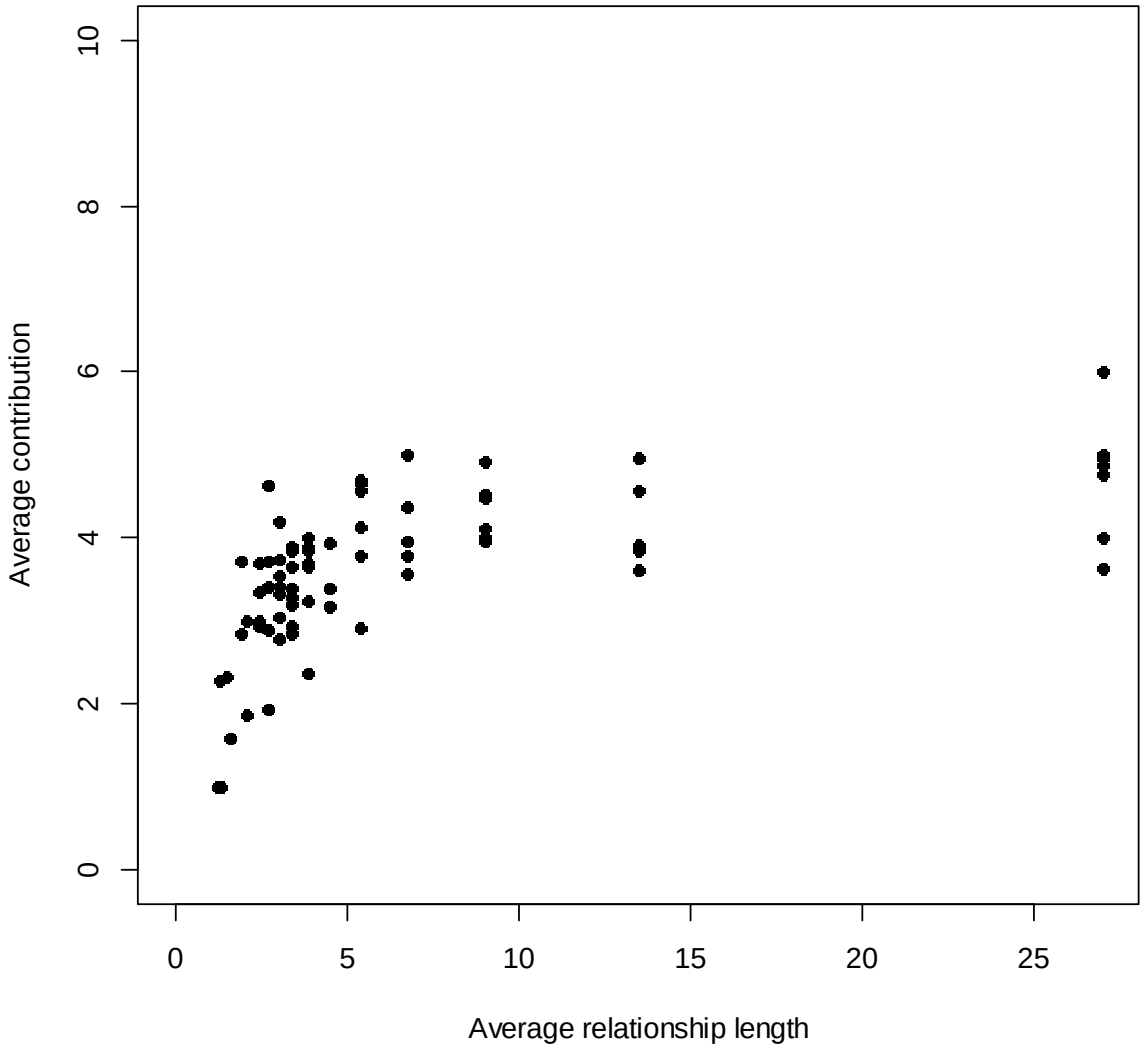

Figure 3: average of individual distributors, given her average relationship-length

This impression of a positive correlation between a distributor´s average relationship-length[13] and her contributions is confirmed by the statistical analysis (Pearson´s product moment correlation = .613, $t(76) = 6.77$, $p < .001$).

Overall, this evidence supports Hypothesis 3i.

[13] When calculating the average relationship length, we do not consider the first 3 rounds were rejection was not possible.

Obviously, a receiver with a longer average relationship rejects less often than a receiver with a smaller average relationship length. As already explained, this may be driven by (a combination of) two different factors. First, distributors belonging to long-lived groups contribute more, and this might trigger higher cooperation rates. Second, receivers of long-lived groups might be genuinely less demanding and therefore more likely to cooperate for a given level of past contributions. To distinguish between the two different reasons for higher cooperation rates, we have calculated for each receiver her average relationship length, and used this average to categorize the receivers into three categories of roughly equal size: receivers with a short average relationship length (SARL) of less than 4.3 rounds (25 receivers); receivers with a long average relationship length (LARL) of more than 8 rounds (28 receivers); medium average relationship length (24 receivers). We do a probit regression with a cooperation dummy as dependent variable. The average contribution of the distributors and the dummies for the receivers with the highest and the lowest average relationship length are the independent variables.

Variable	Coefficient	Std. error	*z*-statistic	Marginal effects
Constant	-.776*	.157	-4.96	-
Average past donation	.591*	.045	13.04	.109
SARL dummy	-.353*	.086	-4.12	-.065
LARL dummy	.100	.111	.91	-.018

Log-likelihood = -710.477

Mc Fadden Pseudo-R^2 = 0.186

Observations = 2106

Test: SARL = LARL, X^2 = 17.66*

Table 3: Probit regression of the impact of average past donations and group duration on cooperative behavior. The dependent variable equals 1 if the receiver decides to cooperate and 0 otherwise. * indicates significance at the 1% level.

As suggested by Hypothesis 3ii, the likelihood of cooperation increases in the average past contribution of the distributors. For given past contribution, the likelihood of cooperation is significantly higher for receivers that exhibit a large or a medium average relationship length than for those with a short average relationship length. We can conclude that receivers who are members of short-lasting groups are more demanding than the other receivers.

Since distributors that belong to long-lived groups contribute more, receivers' earnings should be positively correlated with the average duration of the group he was in. For distributors' earnings there are two opposing effects. On the one hand, higher contributions have a direct negative effect on

distributors' earnings. On the other hand, higher contributions are connected with longer group-durations, and hence with more cooperation. Figure 4 indicates that also for distributors the earnings increase in the average relationship length.

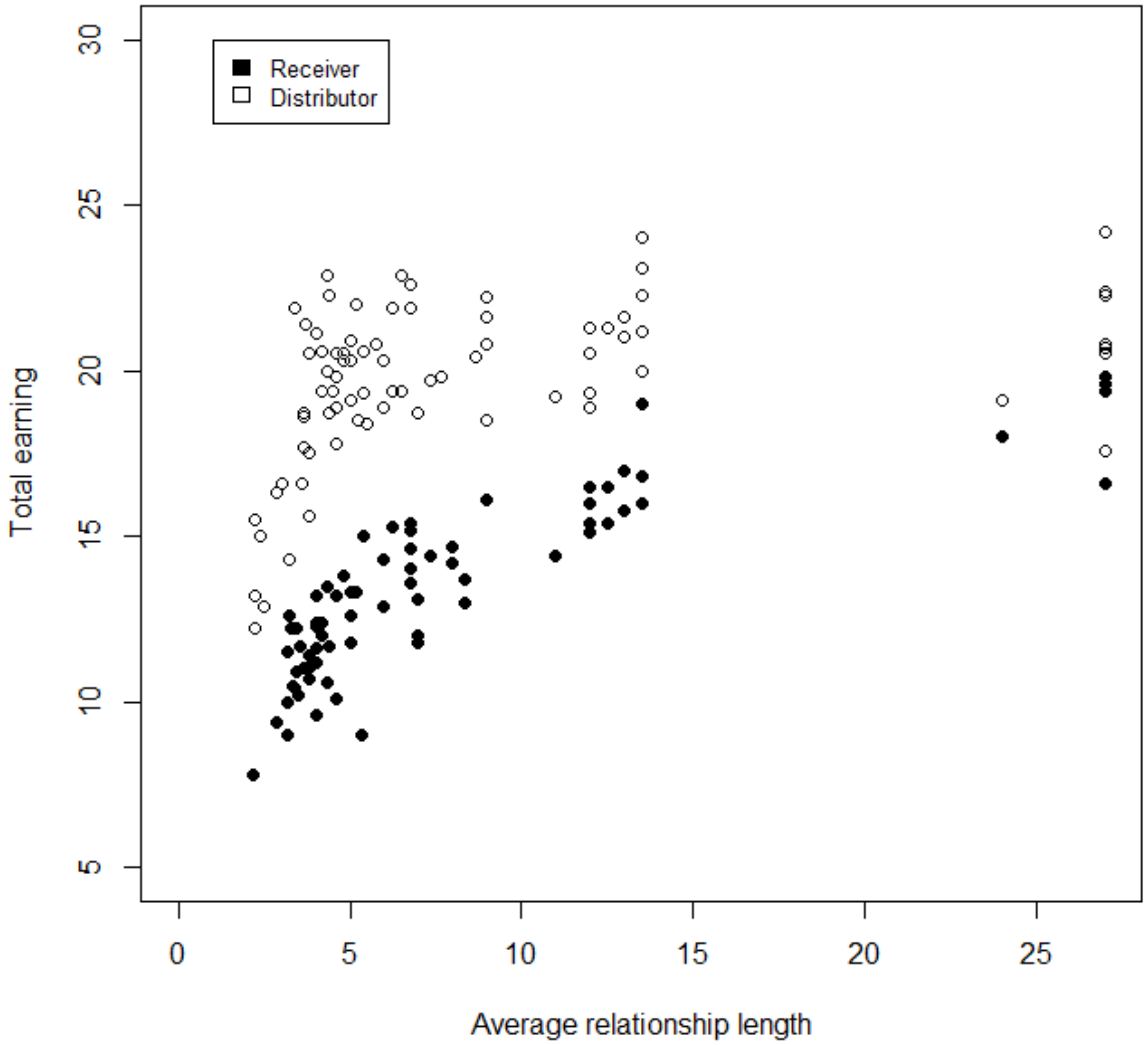

Figure 4: total earnings of individual distributors and receivers, given the average relationship length

This impression is confirmed by looking at the earnings of both types of subjects when we take the SARL/LARL categorization (receivers: two sample t test, SARL – LARL, t(46.49) = -12.178, $p < .001$; distributors: two sample t test, SARL – LARL, t(35.37) = -4.351, $p < .001$). There is also a positive correlation between a subject's average relationship length and his earning (receivers: Pearson's

product-moment correlation = .849, $t(76) = 14.05$, $p < .001$; distributors: Pearson's product-moment correlation = .384, $t(76) = 3.63$, $p < .001$). This confirms Hypotheses 3iii.

Since in the ET we found significant differences between groups of long and short duration we compare the behavior of these different types of ET groups with the behavior found in the RT.

	Difference	lower	upper	Adjusted p-value
Table 4a: Comparison of distributors´ contributions				
Long-lived ET – Short-lived ET	1.637	1.099	2.174	0.000
RT - Short-lived ET	0.710	0.263	1.158	0.001
RT - Long-lived ET	-0.927	-1.362	-0.491	0.000
$F(2,123) = 26.57$, $p < 0.001$, $\eta^2 = 0.30$				
Table 4b: Comparisons of distributors´ earnings				
LARL ET – SARL ET	2.981	1.584	4.378	0.000
RT - SARL ET	2.044	0.879	3.208	0.001
RT - SARL ET	-0.937	-2.069	0.195	0.125
$F(2,123) = 13.65$, $p < 0.001$, $\eta^2 = 0.18$				
Table 4c: Comparisons of receivers´ earnings				
LARL ET – SARL ET	5.537	4.555	6.519	0.000
RT - SARL ET	2.243	1.417	3.068	0.000
RT - LARL ET	-3.294	-4.086	-2.502	0.000
$F(2,124) = 92.63$, $p < 0.001$, $\eta^2 = 0.6$				

Table 4: Values for the 95% family-wise confidence level, Tukey's 'Honest Significant Difference' method. For RT we used the total earnings of all subjects (distributors: 74, receivers: 74), for the SARL ET the total earnings of all subjects that had an average relationship length of less than 4.3 rounds for receivers and 4.6 for distributors (distributors: 25, receivers: 25), and for Long-lived ET the total earnings of all subjects that had an average relationship length of more than or equal to 8 rounds for receivers and 8.6 for distributors (distributors: 27, receivers: 28).

Table 4 shows that distributors belonging to short-lived groups ET groups contribute significantly less than RT distributors, whereas those belonging to long-lived ET groups contribute significantly more. Earnings are larger in the ET than in the RT for both types of subjects whenever they have a long average relationship length, and smaller in the ET whenever they have a short average relationship length. These differences are significant except for the earning difference between RT and the LARL ET distributors.

Concerning cooperation, Table 5 shows the result of the probit regression with the combined data of the ET and the RT.

Variable	Coefficient	Std. error	*z*-statistic	Marginal effects
Constant	-1.258*	.129	-9.78	-
Average past donation	.746*	.036	20.96	.134
SARL ET	-.315*	.087	-3.62	-.056
LARL ET	.006	.112	0.05	.001
RT	-.024	.077	-0.31	-.004

Log-likelihood = -1345.415

Mc Fadden Pseudo-R^2 = 0.194

Observations = 4104

Test: SARL ET = LARL ET X^2 = 8.93*

Test: SARL ET = RT X^2 = 18.56*

Test: LARL ET = RT X^2 = .09

Table 5: Probit regression of the impact of average past donations and group duration on cooperative behavior, for both ET and RT treatments. The dependent variable equals 1 if the receiver decides to cooperate and 0 otherwise. * indicates significance at the 1% level.

Again, higher average past contributions increase the likelihood of cooperation. ET-receivers who stay in the same group for a short time are more demanding than ET-receivers with a medium or long average relationship length. They are also more demanding than the average RT-receivers. This is further evidence that the possibility of staying together leads to self-selection of distributors and receivers.
Overall, the results show that the possibility of repeated cooperation does not increase cooperation and does not lead to more equal outcomes. Rather, subjects self-select into long-lived groups with high cooperation levels and comparably equal allocations, and short-lived groups with low cooperation rates and unequal allocations.

5. Conclusions

Our paper investigates the impact of repeated interaction on cooperation levels and surplus distribution when group formation endogenous. As expected, the possibility to refuse cooperation restricts the possibility of the strong agents to take the lion share of the surplus produced by cooperation. But contrary to our expectations the possibility of repeated interaction did not lead to higher cooperation levels cooperation levels and more equal surplus distributions. Instead, subjects self-selected into long-lived, cooperative groups consisting of generous distributors and undemanding receivers, and short-lived, un-cooperative groups consisting of un-generous distributors and demanding receivers. This result casts doubts whether the repeated interaction can lead to cooperative and efficient outcomes when the ex-post bargaining power about the surplus distribution is very unequal.

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Base treatment (BT)

Experimental Instructions

Dear Participant, welcome!

You are about to participate in an experiment on interactive decision-making, conducted by researchers from the Vrije Universiteit Brussel and the Université Libre de Bruxelles, and funded by the Belgian fund for the scientific research (Fonds de la Recherche Scientifique). In this experiment you will earn some money, and the amount will be determined by your choices and by the choices of the other participants.

Your privacy is guaranteed: all results will be used anonymously.

It is very important that you remain silent during the whole experiment, and that you never communicate with the other participants, neither verbally, nor in any other way. For any doubts or problems you may have, please just raise your hand and an experimenter will approach you. If you do not remain silent or if you behave in any way that could potentially disturb the experiment, you will be asked to leave the laboratory, and you will not be paid.

All your earnings during the experiment will be expressed in **Experimental Currency Units** (ECUs), which will be transformed into Euros with a change rate of 10 to 1. At the end of the experiment, a show up fee of 2.5 euros will be added to your earnings.

You will be paid privately and in cash. Other participants will not be informed about your earnings.

Before starting, you will be randomly assigned to the role of Agent 1 or Agent 2, and you will maintain the role for the whole experiment. During the experiment, two Agents 1 and two Agents 2 will form groups of four people.

The experiment consists of 30 rounds. In each round there will be a random re-grouping of Agents 1 and 2. Obviously, as the matching rule is random and as the number of rounds is larger than the number of participants, you will be matched more than once with the same subjects during the experiment. However, you will never know the identity of the participants you are matched with and hence you will not be able to identify your partners. Your partners will also be unable to identify you.

In each round each Agent 1 receives an endowment of 10 ECUs and has to decide how much to give to the two Agents 2 that have been matched with him/her. The minimal amount to give is 1 ECU, the maximal 10 ECUs. The amount will be equally split between the two Agents 2.

Each Agent 1's gain will be what he/she has decided to keep for him/herself, while each Agent 2's gain will be the sum of what the two matched Agents 1 have given, divided by 2 (since he/she has to share with the other Agent 2).

After the choices of the Agents 1 each Agent 2 will be informed about the amounts that have been given to him/her. Agents 2 do not have to make any decision.

Example: At round X, Agent 1a decides to give 1 ECU, Agent 1b decides to give 3 ECUs. In that round, Agent 1a gains 10-1=9 ECUs, Agent 1b gains 10-3=7 ECUs, and each Agent 2 gains (1+3)/2=2ECUs.

Once the experiment is over, you will have to fill a short questionnaire.

After that, your final earnings will be determined. For Agent 1 the final earnings (in ECUs) are the sum of all those amounts he/she did not give to his/her Agents 2 over all the 30 rounds. For Agent 2, the final earnings are the sum of all those earnings he/she received from his/her Agents 1 during all the 30 rounds.

These final earnings are transformed into Euros with 10 ECUs being equal to 1 euro, and a show up fee of 2.5 euros will be added.

You will be asked to fill a short questionnaire and you will be paid 2.5 euros to complete this task.

Your final earning will appear on the screen and the experimenters will explain the modality of payment.

Thank you for your participation!

Re-match Treatment (RT)

Experimental Instruction

Dear Participant, welcome!

You are about to participate in an experiment on interactive decision-making, conducted by researchers from the Vrije Universiteit Brussel and the Université Libre de Bruxelles, and funded by the Belgian fund for the scientific research (Fonds de la Recherche Scientifique). In this experiment you will earn some money, and the amount will be determined by your choices and by the choices of the other participants.

Your privacy is guaranteed: all results will be used anonymously.

It is very important that you remain silent during the whole experiment, and that you never communicate with the other participants, neither verbally, nor in any other way. For any doubts or problems you may have, please just raise your hand and an experimenter will approach you. If you do not remain silent or if you behave in any way that could potentially disturb the experiment, you will be asked to leave the laboratory, and you will not be paid.

All your earnings during the experiment will be expressed in **Experimental Currency Units** (ECUs), which will be transformed into Euros with a change rate of 10 to 1. At the end of the experiment, a show up fee of 5 euros will be added to your earnings.

You will be paid privately and in cash. Other participants will not be informed about your earnings.

Before starting, you will be randomly assigned to the role of Agent 1 or Agent 2, and you will maintain the role for the whole experiment. During the experiment, two Agents 1 and two Agents 2 will form groups of four people.

The experiment is divided in two parts with a total of 30 rounds. In each round there will be a random re-matching of Agents 1 and 2. Obviously, as the matching rule is random and as the number of rounds is larger than the number of participants, you will be matched more than once with the same subjects during the experiment. However, you will never know the identity of the participants you are matched with and hence you will not be able to identify your partners. Your partners will also be unable to identify you.

PART 1

The first part of the experiment consists of 3 rounds. In each round, each Agent 1 receives an endowment of 10 ECUs and has to decide how much to give to the Agents 2 that have been matched with him/her. The minimal amount to give to Agents 2 is 1 ECU, the maximal 10 ECUs. After the choice, the amount will be split equally between the two Agents 2 and each of them will be informed about the amount that has been given to him/her. Agents 2 do not have to make any decision.

Example: At round X, Agent 1a decides to give 1 ECU, Agent 1b decides to give 3 ECUs. In that round, Agent 1a gains 10-1=9 ECUs, Agent 1b gains 10-3=7 ECUs, and each Agent 2 gains (1+3)/2=2 ECUs.

PART 2

The second part of the experiment consists of 27 rounds (from round 4 to round 30). At the beginning of each round, two Agents 1 and two Agents 2 are matched and form a group. All members of the group see a screenshot that shows what the matched Agents 1 gave in the three last rounds he/she played. Then all agents (both Agents 1 and 2) have to choose whether he/she wants to interact with the group he/she has been matched with, or not.

IF NOT, i.e. if at least one agent refuses to interact, the group is dissolved. All agents of this group skip this round and go directly to the following one, where they will be matched with new partners. When an interaction is refused, each agent of the group will gain 0 ECUs for that round. Refusals are not shown in the screenshot that summarizes the three previous periods.

IF YES, i.e. if all agents of a group accept to interact, the group stays together during this round. In this case, both Agents 1 receive 10 ECUs and chooses how much to give to Agents 2, with a minimum of 1 and a maximum of 10 ECUs. After the choice, each Agent 2 will be informed about the amount that has been given to him/her.

As already explained, at the beginning of each round a screenshot informs each agent what the randomly matched Agents 1 gave in the three last rounds he/she played. Agents will not see if in the previous rounds any agent refused to interact with a specific Agent 1.

Once the experiment is over, you will have to fill a short questionnaire.

After that, your final earnings will be determined. For Agent 1 the final earnings (in ECUs) are the sum of all those amounts he/she did not give to his/her Agents 2 over all the 30 rounds. For Agent 2, the final earnings are the sum of all those earnings he/she received from his/her Agents 1 during all the 30 rounds.

These final earnings are transformed into Euros with 10 ECUs being equal to 1 euro, and a show up fee of 5 euros will be added.

Your final earning will appear on the screen and the experimenters will explain the modality of payment.

Thank you for your participation!

Endogenous-match Treatment (ET)

Experimental Instructions

Dear Participant, welcome!

You are about to participate in an experiment on interactive decision-making, conducted by researchers from the Vrije Universiteit Brussel and the Université Libre de Bruxelles, and funded by the Belgian fund for the scientific research (Fonds de la Recherche Scientifique). In this experiment you will earn some money, and the amount will be determined by your choices and by the choices of the other participants.

Your privacy is guaranteed: all results will be used anonymously.

It is very important that you remain silent during the whole experiment, and that you never communicate with the other participants, neither verbally, nor in any other way. For any doubts or problems you may have, please just raise your hand and an experimenter will approach you. If you do not remain silent or if you behave in any way that could potentially disturb the experiment, you will be asked to leave the laboratory, and you will not be paid.

All your earnings during the experiment will be expressed in **Experimental Currency Units** (ECUs), which will be transformed into Euros with a change rate of 10 to 1. At the end of the experiment, a show up fee of 5 euros will be added to your earnings.

You will be paid privately and in cash. Other participants will not be informed about your earnings.

Before starting, you will be randomly assigned to the role of Agent 1 or Agent 2, and you will maintain the role for the whole experiment. During the experiment, two Agents 1 and two Agents 2 will form groups of four people.

The experiment is divided in two parts with a total of 30 rounds. You will never know the identity of the participants you are matched with in the different rounds - you will not be able to identify your partners. Your partners will also be unable to identify you.

PART 1

The first part of the experiment consists of 3 rounds. During these three rounds, you will be matched with the same agents - the composition of your group will not change. In each round, each Agent 1 receives an endowment of 10 ECUs and has to decide how much to give to the Agents 2 that have been matched with him/her. The minimal amount to give to Agents 2 is 1 ECU, the maximal 10 ECUs. After the choice, the amount will be split equally between the two Agents 2 and each of them will be informed about the amount that has been given to him/her Agents 2 do not have to make any decision.

Example: At round X, Agent 1a decides to give 1 ECU, Agent 1b decides to give 3 ECUs. In that round, gent 1a gains 10-1=9 ECUs, Agent 1b gains 10-3=7 ECUs, and each Agent 2 gains (1+3)/2=2 ECUs.

PART 2

The second part of the experiment consists of 27 rounds (from round 4 to round 30).

At the beginning of round 4 of this part of the experiment, each agent (both Agents 1 and 2) will have to choose whether he/she wants to maintain the group he/she has interacted with in the previous round, or not. To reach a decision, all members of the group see a screenshot that shows what the matched Agents 1 gave in the three last rounds he/she played.

IF NOT, i.e. if at least one agent does not want to maintain the group, it is dissolved. All agents of this group skip this round and go directly to the following one, where they will be matched with new partners. When the group is dissolved, each agent of the group will gain 0 ECUs for that round. Refusals are not shown in the screenshot that summarizes the three previous periods.

IF YES, i.e. if all agents of the group want to maintain it, the group stays together during this round. In this case, both Agents 1 receive 10 ECUs and chooses how much to give to Agents 2, with a minimum of 1 and a maximum of 10 ECUs. After the choice, each Agent 2 will be informed about the amount that has been given to him/her.

From round 5 to round 30, at the beginning of each round each agent will have to choose whether he/she accepts to interact with the proposed group, or whether he/she prefers to be matched with new partners.

If in the previous round your group has been dissolved, then you will be matched randomly with the available agents.

If in the previous round your group was not dissolved, each group member has to choose again whether he/she wants to maintain the group in this round, or not. If it is dissolved in this round, every group member earn 0 ECUs in this round, and a new matching takes place in the next round. If the group is again maintained, each Agent 1 has to decide about the split of his 10 ECUs as described before.

As already explained, at the beginning of each round a screenshot informs each agent the Agents 1 he/she is matched with gave in the three last rounds the respective Agent 1 played. Agents will not see if in the previous rounds any agent refused to interact with a specific Agents 1.

Please keep in mind that if your group is dissolved, in the next round you will be randomly re-matched. But if all the other groups have been maintained, your group will be re-formed with the same agents.

Once the experiment is over, you will have to fill a short questionnaire.

After that, your final earnings will be determined. For Agent 1 the final earnings (in ECUs) are the sum of all those amounts he/she did not give to his/her Agents 2 over all the 30 rounds. For Agent 2, the final earnings are the sum of all those earnings he/she received from his/her Agents 1 during all the 30 rounds.

These final earnings are transformed into Euros with 10 ECUs being equal to 1 euro, and a show up fee of 5 euros will be added.

Your final earning will appear on the screen and the experimenters will explain the modality of payment.

Thank you for your participation!

QUESTIONNAIRE

Dear Participant,

the following questionnaire is anonymous and has the sole purpose of verifying your understanding of the rules of this experiment.

We ask you to answer to the following questions. If you are uncertain about how to respond, please consult the instructions sheet or the experimenter.

Once you have finished, please raise your hand and an experimenter will come and check your answers.

If Agent 1a decides to give 3 ECUs, and Agent 1b decides to give 5 ECUs, how many ECUs will each of the four agents of the group in that round?

Agent 1a…….. Agent 1b……

Agent 2a..... Agent 2b……

If Agent 1a decides to give 4ECUs, and Agent 1b decides to give 2 ECUs, how many ECUswill each of the four agents of the group in that round?

Agent 1a…….. Agent 1b……

Agent 2a..... Agent 2b……

In the second part of the experiment, will the group be dissolved if one of the agents decides so?

YES NO

In the second part of the experiment, will the groups be randomly re-matched at each round?

YES NO

In the second part of the experiment, if one agent decides not to maintain the randomly selected group, how many ECUs will each group member earn in that round? ……